Care of asthma patients in relation to guidelines

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ABSTRACT

Clinical asthma care may have to change to be brought in line with Expert Panel Report 3 (EPR3) guidelines, which recommend increased intensity of therapy (steps) to treat uncontrolled asthma. This study determined if asthma therapy steps can be identified using claims data and if patients have appropriate step-up in therapy if their disease is not controlled. A cohort study was performed using an administrative claims database and involving patients 12–64 years old with uncontrolled asthma events (either impairment or risk). Patients were assigned to a preindex step (6 months before the index date) and postindex steps (1 year after the index date). The primary study outcome was a change in therapy steps. We used logistic regression to identify variables predictive of an increase in step. Our algorithm for assigning steps appeared internally valid; patients identified as being at higher steps saw more specialists and had higher levels of asthma risk. Among 14,781 patients for which a step-up option existed, 12.4–41.3% had a step-up in therapy after an uncontrolled asthma event. For all steps, high-risk patients had higher odds of having a step-up in therapy than low-risk patients. The odds ratio for appropriate therapy increased with increasing baseline step: from 1.50 for step 2 versus step 1, to 11.41 for step 5 versus step 1. Steps can be assigned using claims data. Bringing care in line with EPR3 guidelines will require significant changes from current practice but will improve quality by reducing use of oral corticosteroids and increasing use of inhaled steroids.

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More than 20 million individuals in the United States have asthma, and asthma attacks account for 1.7 million emergency visits and 440,000 hospitalizations per year.[1] The 2007 *Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma*, developed by the National Heart, Lung, and Blood Institute (NHLBI), describes six steps of therapy.[2] The goal of asthma therapy is disease control, which comprises current impairment and future risk. Impairment assesses the frequency and severity of symptoms; the use of rescue inhalers; lung function; and functional limitations. Risk assesses the probability of whether a patient will have future exacerbations. When asthma is not controlled, Expert Panel Report 3 (EPR3) recommends increasing the intensity of, or "stepping up" therapy.[2] Although the care recommended in EPR3 has similarities to current standards, there are significant differences. Current asthma care may have to change to be brought in line with these guidelines; the degree of change needed is not known.

Evaluating care in relation to guidelines can be difficult and time-consuming. A method for using administrative claims for evaluating what step of therapy an asthma patient uses would simplify this process. We developed an algorithm to identify therapy step using administrative claims and used the algorithm to examine how physicians changed therapy in response to evidence of poor control. The goal was to assess care at baseline, before attempts were made to align care with EPR3. We focused on the extent to which increases in current practices regarding therapeutic intensity, use of oral corticosteroids (OCS), and use of specialist care would have to be modified to fit the new guidelines.

METHODS

This was a cohort study that used administrative claims to develop an algorithm to identify therapy step among asthma patients and to examine whether therapy step increased among asthma patients whose disease was not well controlled. We used the Ingenix i3 LabRx database, a Health Insurance Portability and Accountability Act–compliant administrative claims database of 8–10 million covered lives. This database contains adjudicated pharmacy and medical claims submitted by providers, health care facilities, and pharmacies. Claims include information on each physician visit, medical procedure, hospitalization, drug dispensed, and test performed. Also available are member enrollment and benefit information as well as limited patient, provider, and hospital demographic information. All major regions of the United Statets are represented in the data. The study was exempt from review by the human subjects protection committee.

Subjects

We identified patients 12–64 years old with evidence of uncontrolled asthma during the identification pe-

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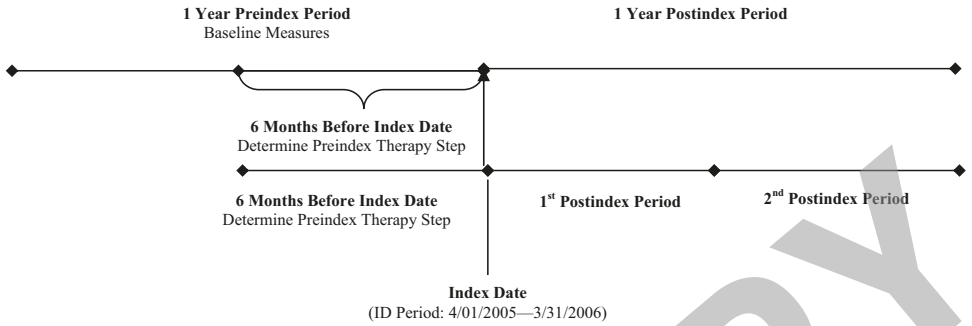

Figure 1. *Study time frame. ID, identification.*

riod (April 1, 2005 to March 31, 2006; Fig. 1). Relying on prior literature, we defined evidence of asthma as an inpatient claim with an asthma diagnosis (International Classification of Diseases, Ninth Revision [ICD-9]: 493.xx) in any field, an emergency department (ED) or outpatient visit with a primary diagnosis of asthma, and two or more dispensing events for asthma medications (including short- or long-acting β-agonists [SABA or LABA], inhaled corticosteroids [ICS], combination ICS/LABA, cromolyn sodium, leukotriene receptor antagonist, nedocromil, zileuton, theophylline, and omalizumab).

Using the EPR3 definitions and published studies as a guide, we defined uncontrolled asthma as the presence of either risk or impairment. We defined "impairment" to be present if a patient filled prescriptions for seven or more SABA in 1 year[2,3] and "risk" to be present if a patient had two or more of the following events: an asthma-related ED visit, an asthma-related hospitalization, and an OCS fill that occurred within 7 days of a physician visit.[2]

For patients with impairment, the index date was the date of their seventh SABA fill (the date on which they met the definition of impairment). For patients with risk, the index date was the date of the second asthma exacerbation. We excluded patients who were not continuously enrolled during the year before and after the index date. We also excluded patients with cystic fibrosis (ICD-9: 277.xx), chronic obstructive pulmonary disease (ICD-9: 491.2, 493.2, 496.x, and 506.4), emphysema (ICD-9: 492.x, 506.4, 518.1, and 518.2), bronchopulmonary dysplasia (ICD-9: 770.7), and those who were pregnant during the study period.

Variables

All baseline measures were determined in the 1-year preindex period. Demographic measures included age, gender, and region of residence. Clinical measures included asthma-related comorbidities (*e.g.*, sinusitis, rhinitis, and tonsillitis); evidence of allergy, determined using claims for relevant diagnoses and treatments; and asthma risk stratification, determined using a previously validated three-level system.[4] We also examined nonasthma-related acute or chronic conditions. For acute conditions, we used Clinical Classifications Software, a validated method developed by the Agency for Health Care Research and Quality, to cluster patient diagnoses into broad disease categories.[4] We counted the number of chronic conditions using the method of Hwang *et al.*[5] Utilization measures included the number of physician visits (classified as primary care, allergist, pulmonologist, or other), the use of asthma-related medication during the 6 months before the index date, and the specialty of each patient's usual-care physician.[6] A usual-care physician was categorized as primary care, allergist, pulmonologist, or other. Patients assigned to "other" included those with usual care from specialties not generally associated with asthma care (*e.g.*, cardiology and dermatology) and those for whom a usual-care physician could not be assigned because of missing specialty information.

We developed and tested a claims-based algorithm to identify therapy step. The algorithm defined steps according to EPR3 and added two additional categories, "no asthma treatment" and "undefined" (see Appendix). Undefined was defined as asthma treatment combinations not matching a guideline step. In practice, care may be changed at any time, but in commercially insured populations, many medications are filled only every 3 months. Accounting for missed fills, it was impractical to assign a therapy step using a period shorter than 6 months. We identified steps in three 6-month periods: a single preindex period and two nonoverlapping postindex periods.

EPR3-preferred therapies for steps 3–4 differ in the dose of ICS used. For fluticasone/salmeterol (ICS + LABA) medications, we assumed patients had low, medium, and high daily dosages if they filled prescriptions with strengths of 100/50 μg, 250/50 μg, and 500/50 μg, respectively. For other medications we used information from claims (days of supply and quantity), from the National Drug Code reference table (strength and package size) and from the manufacturer (number of puffs per canister) to calculate the daily dosage for each claim. ICS claims were assigned as low, medium, or high dose based on this calculated

daily dose. Step 6 requires "long-term use of OCSs," which we defined as a total supply of ≥60 days in a 6-month period. To internally validate the step assignment algorithm, we compared our assigned step with a validated claims-based measure of asthma risk[7] and with intensity of pulmonologist/allergist visits.

The primary study outcome was the proportion of patients with an increase in therapy step after they had evidence of lack of asthma control (either risk or impairment). We looked for evidence of increased step between the preindex period and either of the two postindex periods to allow time for the clinician(s) to react to a lack of control and for evidence of such a reaction to appear in claims. We accepted any increase in step from the preindex period to either postindex period as being consistent with EPR-3 guidelines, even if care later returned to baseline. Secondary outcomes included specialist visits and OCS use after the index event.

Statistical Methods

We reported descriptive statistics for baseline measures. Means with standard deviations were reported for continuous variables, and patient counts with percentages were reported for categorical variables. To test our claims-based algorithm for assigning step, we compared risk stratification, number of physician visits, and physician specialty across each step of care using chi-square and *F*-tests. To examine the response to poor control, we described increase in step, use of specialists, and use of OCS, stratified by baseline step. We used logistic regression models to identify which baseline characteristics were associated with an increased step. Separate logistic regression models were conducted for each preindex therapy step.

The baseline characteristics included in the logistic models were determined *a priori* and included age, gender, region, index events, risk stratification, usual-care physician specialty, any allergist or pulmonologist visits, number of physician visits, sinusitis, rhinitis, acute upper respiratory infection, cough, other asthma-related comorbidity (including tonsillitis, conjunctivitis, or nasal polyposis), and number of chronic conditions. We reported adjusted odds ratios (OR) and their 95% confidence intervals.

In the main analysis, if a patient had both impairment and risk, we included both uncontrolled asthma events independently. In a sensitivity analysis, we included only the earlier of the two events. All data transformations and statistical analyses were performed using SAS Version 9.1 (SAS Institute, Cary, NC).

RESULTS

We identified 580,955 patients meeting our definition of asthma, most of whom (501,527) had no evidence of lack of control. After excluding 28,220 who did not meet the age criteria; 28,940 who were not continuously enrolled for 2 years; and 9,303 who had chronic obstructive pulmonary disease, emphysema, cystic fibrosis, pregnancy, or bronchopulmonary dysplasia, we had 18,343 episodes of uncontrolled asthma. The mean (±SD) patient age was 39.6 years (±14.6 years), half were between 35 and 54 years old, and 58.2% were women. Reflecting the geographic range of the claims database, all major regions of the country were represented: 34.1% of patients were from the Midwest, 10.5% were from the Northeast, 41.1% were from the South, and 14.4% were from the West (Table 1). Patients in higher baseline steps were older (48.4 years in step 6 versus 37.6 years in step 1). Acute asthma-related comorbidities were common, with 40.0% having at least one claim for rhinitis, 36.7% for sinusitis, 22.9% for cough, and 20.6% for acute upper respiratory infection. Patients had a mean of 3.3 chronic conditions (including asthma). There were differences in comorbidity across step categories, with those in higher steps generally having more comorbidities (acute and chronic) than those in lower steps (Table 2).

The algorithm for step assignment classified 14,886 patients as steps 1–6. No asthma treatment was identified for 759 patients. An additional 2698 patients had treatment during the preindex period that was not consistent with any EPR3-based step. Most (65.3%) filled OCS prescriptions without any other asthma medication. The second largest group (26.8%) filled high-dose ICS but no LABA prescriptions.

We tested the internal validity of our algorithm with several comparisons among the patients assigned to steps 1–6. We used a validated, claims-based system to measure risk of exacerbation.[7] Twenty-six percent (n = 3911) were assessed as having low risk, 61% (n = 9116) were assessed as medium, and 12.5% (n = 1859) were assessed as high. As steps increased, the proportion of patients classified as low risk decreased (35.3% of step 1 patients versus 0% of step 6 patients) and the proportion classified as high risk increased (10% of step 1 patients versus 33% of step 6 patients; Fig. 2).

As further validation of our algorithm, we examined the relationship between assigned step and physician use. Primary care physicians were the usual-care physicians for 69.8% of patients, allergists for 9.6% of patients, and pulmonologists for 3.8% of patients. In the preindex year, patients had a mean of 4.8 primary care visits, 1.8 allergist visits, and 0.4 pulmonologist visits. Patients assigned to higher steps in the preindex period were more likely to have specialists as their usual-care physicians. Patients in higher steps also tended to have more specialist and more generalist visits than those in lower steps (Fig. 3).

We classified 14,781 patients as steps 1–5 during the 6 months before they had evidence of poor control, and we examined the change in their care in the year after the index event. Patients at step 6 were ineligible to be stepped up and were not analyzed. Twenty-seven per-

Table 1 **Demographic characteristics of 18,343 patients with evidence of lack of asthma control**

	Preindex Therapy								All
	No Treatment	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Undefined	
n	759	4678	2475	2255	3697	1676	105	2698	18,343
Percent	4.1	25.5	13.5	12.3	20.2	9.1	0.6	14.7	100.0
Age (yr)									
Mean	38.0	37.6	39.1	38.2	40.4	42.5	48.4	41.7	39.6
SD	15.7	14.1	15.0	15.6	14.5	13.4	11.4	14.1	14.6
Female									
n	482	2510	1531	1329	2088	963	54	1721	10,678
%	63.5	53.7	61.9	58.9	56.5	57.5	51.4	63.8	58.2
Region									
Midwest									
n	200	1645	844	756	1240	659	42	862	6248
Col %	26.4	35.2	34.1	33.5	33.5	39.3	40.0	31.9	34.1
Row %	3.2	26.3	13.5	12.1	19.8	10.5	0.7	13.8	100.0
Northeast									
n	75	472	271	248	383	174	10	290	1,923
Col %	9.9	10.1	10.9	11.0	10.4	10.4	9.5	10.7	10.5
Row %	3.9	24.5	14.1	12.9	19.9	9.0	0.5	15.1	100.0
South									
n	418	1832	1102	873	1,483	582	39	1210	7539
Col %	55.1	39.2	44.5	38.7	40.1	34.7	37.1	44.8	41.1
Row %	5.5	24.3	14.6	11.6	19.7	7.7	0.5	16.0	100.0
West									
n	66	729	258	378	591	261	14	336	2633
Col %	8.7	15.6	10.4	16.8	16.0	15.6	13.3	12.5	14.4
Row %	2.5	27.7	9.8	14.4	22.4	9.9	0.5	12.8	100.0

Col = column.

cent were at a higher step of therapy during the postindex period than during the preindex period. We looked for other changes in care and found that 42.8% of patients had filled OCS prescriptions within 7 days of a physician visit during the postindex period. In addition, 33.8% of patients saw a specialist in the year after the index event.

The proportion of patients whose care changed in each of these ways varied by preindex step. Increasing step was more common for those at lower baseline steps: 41.3% of those in step 1 at baseline had an increase in step postindex, compared with 12.4% of those at step 5. Conversely, OCS prescriptions and specialist care both were more common with increasing baseline therapy step. OCS prescriptions were filled for 33.2% of those in step 1 and 57.0% in step 5. Twenty percent of step 1 patients visited a specialist after their index event compared with 52% of step 5 patients (Fig. 4).

To control for baseline differences and to estimate the impact of various characteristics on the likelihood of having care stepped up, we conducted five logistic regression models, one for each preindex step. Separate models were conducted for each preindex step because exploratory models showed that behavior differed substantially across steps. Each model examined the effect of baseline variables on stepping up care.

For all steps, high-risk patients were more likely to step up in therapy than low-risk patients. The degree of increase in odds varied from an OR of 1.50 for step 2 to an OR of 11.4 for step 5. For most baseline steps, an increase in step was more likely among those whose evidence of lack of control came as a second OCS fill than a seventh SABA fill. There were no other consistent predictors of stepping up (Table 3). In a sensitivity analysis, we only included the first uncontrolled asthma event for each patient. This analysis excluded the second uncontrolled event for 867 patients with evidence of both impairment and risk, leaving 17,476 unique patients. We repeated the regression models with this group, and the results were substantively unchanged from the main analysis.

DISCUSSION

In the current health care environment, evidence-based care has assumed a high profile. Clinicians are being admonished to eliminate errors and follow

Table 2 **Acute and chronic comorbidities at baseline among 18,343 patients with evidence of lack of asthma control**

	Preindex Therapy								All
	No Treatment $n = 759$	**Step 1** $n = 4678$	**Step 2** $n = 2475$	**Step 3** $n = 2255$	**Step 4** $n = 3697$	**Step 5** $n = 1676$	**Step 6** $n = 105$	**Undefined** $n = 2698$	$n = 18,343$
Asthma-related comorbidity									
Sinusitis									
n	265	1312	1005	834	1454	726	53	1084	6733
%	34.9	28.0	40.6	37.0	39.3	43.3	50.5	40.2	36.7
Rhinitis									
n	259	1237	1197	964	1662	882	52	1076	7329
%	34.1	26.4	48.4	42.7	45.0	52.6	49.5	39.9	40.0
Tonsillitis									
n	33	180	96	110	129	49	2	107	706
%	4.3	3.8	3.9	4.9	3.5	2.9	1.9	4.0	3.8
Acute URI									
n	164	911	520	435	799	357	15	580	3,781
%	21.6	19.5	21.0	19.3	21.6	21.3	14.3	21.5	20.6
Conjunctivitis									
n	41	236	178	149	244	147	10	218	1223
%	5.4	5.0	7.2	6.6	6.6	8.8	9.5	8.1	6.7
Chronic otitis media									
n	3	33	17	13	36	18	2	26	148
%	0.4	0.7	0.7	0.6	1.0	1.1	1.9	1.0	0.8
Nasal polyposis									
n	9	46	97	70	135	106	14	82	559
%	1.2	1.0	3.9	3.1	3.7	6.3	13.3	3.0	3.0
Cough									
n	189	885	557	498	898	478	28	667	4200
%	24.9	18.9	22.5	22.1	24.3	28.5	26.7	24.7	22.9
No. of chronic conditions									
Mean	3.1	2.7	3.4	3.1	3.4	3.8	5.0	3.8	3.3
SD	2.5	2.3	2.5	2.4	2.4	2.5	2.9	2.8	2.5

URI = upper respiratory infection.

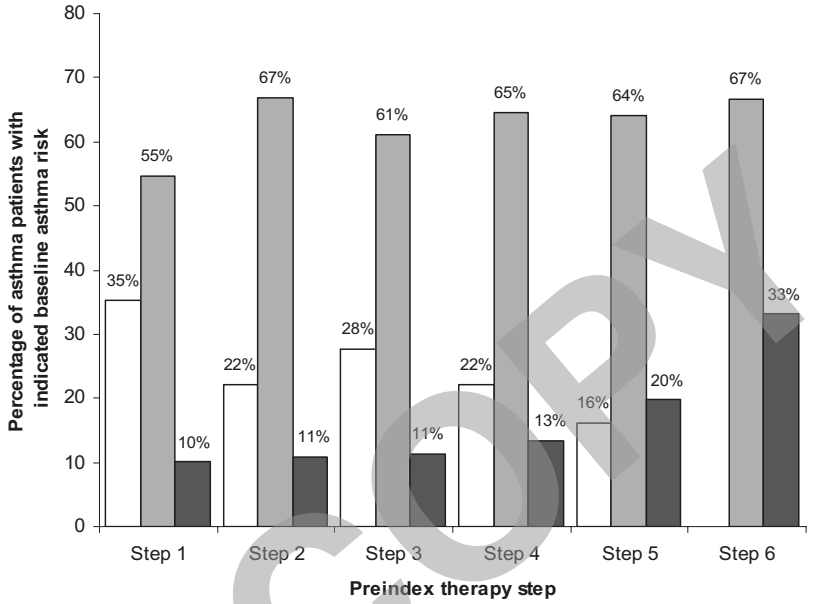

Figure 2. Baseline asthma risk by preindex therapy step for asthma patients in steps 1–6. □ Low ▩ Medium ■ High.

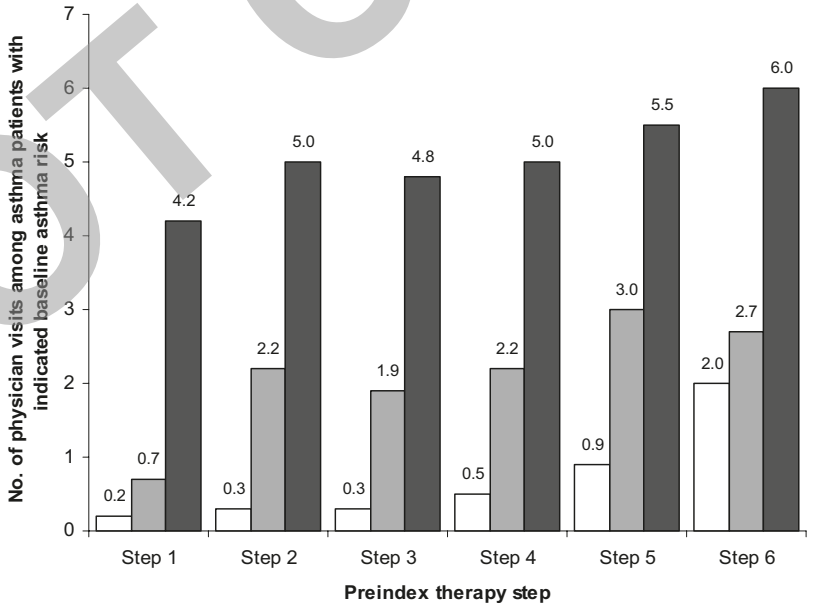

Figure 3. Physician visits by preindex therapy step for asthma patients in steps 1–6. □ Pulmonologist ▩ Allergist ■ Primary Care.

best practices, such as those laid out in clinical practice guidelines.[8] At the health plan level, improving guideline adherence begins with measuring the extent to which practices diverge from those guidelines at baseline. This measurement process can be complex, particularly when using secondary data. Insurance claims lack the clinical detail used to make medical decisions, and researchers can not use them to determine if there are extenuating reasons for nonadherence to guidelines. However, experience with the National Committee for Quality Assurance's (NCQA) Health Care Effectiveness Data and Information Set suggests that measuring and reporting adherence to standards can noticeably improve care.[9] If claims-based measures of adherence are not available, more costly and time-consuming methods must be used, possibly reducing the chance that guideline adherence will be improved.

We created a claims-based algorithm for grouping patients with evidence of poor control into the treatment steps defined in the 2007 NHLBI Asthma Guidelines. Our goal was to use this algorithm to test the current level of adherence with a key recommendation of EPR3: therapeutic intensity should increase in the presence of poor control. To validate it, we applied the algorithm in a Health Insurance Portability and Accountability Act–compliant administrative claims database and found greater use of specialist care in patients we identified as being at higher steps of therapy. Those identified as being at

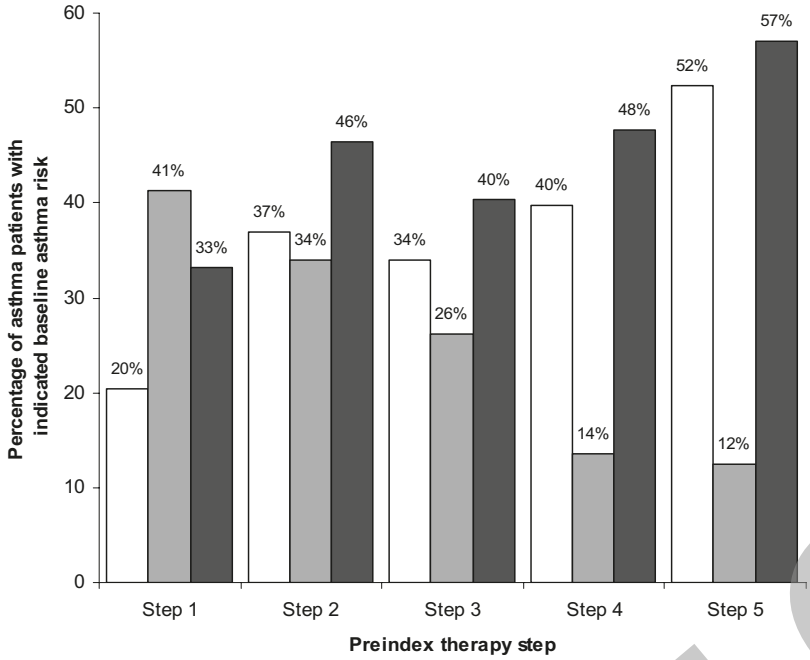

Figure 4. Asthma care after the index event for patients in steps 1–5 at baseline. □ Any specialist visit ▒ Any therapy set up ■ Any use of oral corticosteroids associated with doctor visit.

higher steps also had a greater risk of exacerbation as measured by a claims-based tool, a modification of which has been used in several recent studies.[7,10–12] The combination of these findings gives us some confidence that our step assignment algorithm functioned as planned. Our data had no patient identifiers, so we could not validate our assignment with a review of medical records or survey. Such external validation would be extremely useful, and we are pursuing methods of conducting such studies.

There were significant differences between the care received by patients with uncontrolled asthma and that recommended by EPR3. Of the patients who were classified as steps 1–5, only 28% had evidence that therapy was stepped up as recommended. Perhaps more concerning, the more severely ill patients were less likely than their lower-step counterparts to have recommended changes in medications and were instead more likely to have OCS prescriptions. Most step 5 patients filled an OCS prescription after they were shown to have inadequate control, but only 12% had the EPR3-recommended use of ICSs, LABAs, or omalizumab. Long-term reliance on OCSs alone may have serious clinical consequences.[2] Clinicians may need to become more comfortable increasing therapeutic intensity for patients at steps 3–5 who are already using ICS/LABA inhalers. Our findings of potential undertreatment are consistent with recent studies showing that adults whose asthma was not well controlled in the past are at higher risk of future poor control.[10,11,13]

Asthma specialist care appears to be underused, and this may have contributed to the underuse of appropriate therapy for the sickest patients. EPR3 recommends specialist consultation at step 4 or higher, but fewer than one-half of these patients had appropriate specialist visits. Nonspecialists may be more comfortable moving from step 2 to 3 (which can be done by adding low-dose combination ICS/LABA therapy) than moving from step 4 to 5 (which requires the use of high-dose ICS). A survey of primary care physicians found that a substantial minority held views of controller use that were inconsistent with guidelines.[14] Because the guidelines are new, it is difficult to compare our findings directly with those in prior studies. In a comprehensive review of U.S. health care quality, Schuster and colleagues found that asthma quality indicators were followed in 30–45% of cases.[8] A recent study of asthma care in ED found 67% concordance of care with 12 specific guideline elements.[15] Commercial health plans report 92.3% compliance with the Health Health Care Effectiveness Data and Information Set Effectiveness Data and Information Set asthma measure that requires prescription of at least one controller medication.[9]

This study had limitations. EPR3 recommends that step assignment be clinically based, but clinical detail is extremely limited in administrative claims data. If we systematically misidentified steps, our findings would be biased. We compared our step assignment with several variables and found a reasonable association, but we did not perform a "gold standard" comparison with clinicians or medical records. All of the usual limitations associated with using administrative claims data (*e.g.*, miscoding, not applicable to noncommercially insured populations) apply to our study. Even with those limitations, our methodology can be used in future claims analyses to track changes in patterns of care.

Table 3 **Adjusted odds ratios (OR) for any step-up care after the index event, stratified by preindex therapy step**

	Preindex Therapy				
	Step 1 OR (95% CI)	**Step 2 OR (95% CI)**	**Step 3 OR (95% CI)**	**Step 4 OR (95% CI)**	**Step 5 OR (95% CI)**
Age group (yr)					
55–64 vs 12–17	**0.73 (0.57–1 0.95)**	**0.64 (0.46–0.89)**	1.02 (0.71–1.47)	1.07 (0.73–1.59)	**3.52 (1.56–7.96)**
45–54 vs 12–17	0.86 (0.69–1.06)	**0.64 (0.48–0.85)**	1.06 (0.78–1.45)	1.08 (0.75–1.54)	**2.84 (1.30–6.19)**
35–44 vs 12–17	0.84 (0.68–1.04)	0.88 (0.66–1.17)	1.28 (0.94–1.74)	1.26 (0.88–1.79)	**3.25 (1.47–7.19)**
18–34 vs 12–17	0.84 (0.68–1.03)	0.89 (0.67–1.20)	0.98 (0.71–1.35)	1.08 (0.74–1.58)	1.01 (0.41–2.50)
Women vs men	1.02 (0.90–1.16)	1.10 (0.92–1.33)	**0.80 (0.66–0.98)**	1.13 (0.92–1.39)	0.90 (0.65–1.25)
Region					
West vs South	**1.23 (1.03–1.47)**	**1.45 (1.09–1.93)**	1.09 (0.82–1.44)	1.13 (0.85–1.51)	0.84 (0.51–1.38)
Northeast vs South	1.17 (0.95–1.45)	0.98 (0.73–1.30)	0.99 (0.71–1.38)	1.08 (0.77–1.52)	0.74 (0.40–1.38)
Midwest versus South	1.04 (0.90–1.20)	0.89 (0.73–1.09)	1.07 (0.86–1.35)	1.18 (0.94–1.48)	1.26 (0.88–1.80)
Index events					
Two OCSs with physician visits vs impairment	**1.62 (1.37–1.93)**	1.11 (0.87–1.43)	**1.40 (1.05–1.88)**	1.17 (0.90–1.52)	**2.06 (1.36–3.11)**
One OCS with physician visit and one emergency hospital care episode vs impairment	1.98 (1.50–2.61)	1.46 (0.95–2.23)	**1.84 (1.22–2.77)**	1.40 (0.89–2.22)	0.97 (0.43–2.18)
Two emergency hospital care episodes vs impairment	1.46 (0.63–3.40)	0.52 (0.13–2.05)	0.95 (0.25–3.70)	0.39 (0.09–1.71)	0.46 (0.06–3.70)
Risk stratification					
High risk vs low risk	**2.08 (1.64-.64)**	**1.50 (1.07–2.11)**	**1.63 (1.11–2.38)**	**2.11 (1.42–3.14)**	**11.41 (3.90–33.44)**
Medium risk vs low risk	1.12 (0.95–1.34)	0.99 (0.74–1.31)	1.26 (0.91–1.74)	**1.68 (1.18–2.41)**	**4.14 (1.42–12.13)**
Usual-care physician specialty					
Other vs primary care	1.05 (0.89–1.23)	0.87 (0.68–1.10)	0.96 (0.73–1.26)	1.31 (1.00–1.72)	**1.61 (1.01–2.57)**
Allergist vs primary care	0.80 (0.57–1.13)	1.05 (0.76–1.46)	0.86 (0.58–1.27)	0.99 (0.69–1.43)	1.53 (0.94–2.49)
Pulmonologist vs primary care	0.79 (0.48–1.32)	1.32 (0.80–2.21)	0.91 (0.49–1.70)	**1.61 (1.05–2.47)**	**2.52 (1.45–4.37)**
Any allergist/pulmonologist visits: yes vs no	1.14 (0.91–1.42)	1.24 (0.97–1.58)	0.95 (0.72–1.26)	0.92 (0.71–1.20)	0.93 (0.61–1.44)
Number of doctor visits					
25+ vs 0–4	0.75 (0.58–0.97)	1.10 (0.76–1.57)	1.00 (0.67–1.49)	**1.72 (1.11–2.67)**	**2.55 (1.01–6.43)**
13–24 vs 0–4	0.87 (0.70–1.08)	1.13 (0.81–1.57)	1.04 (0.73–1.49)	**1.58 (1.05–2.36)**	1.71 (0.69–4.23)
5–12 vs 0–4	0.93 (0.79–1.10)	1.07 (0.81–1.41)	1.01 (0.75–1.36)	1.35 (0.94–1.95)	1.51 (0.62–3.64)
Sinusitis: yes vs no	1.04 (0.91–1.20)	0.98 (0.81–1.18)	0.95 (0.77–1.18)	0.99 (0.81–1.22)	1.06 (0.75–1.48)
Rhinitis: yes vs no	**1.24 (1.06–1.45)**	0.83 (0.68–1.01)	1.26 (1.00–1.59)	1.20 (0.96–1.50)	1.15 (0.78–1.70)
Acute URI: yes vs no	1.01 (0.86–1.18)	1.15 (0.93–1.42)	0.98 (0.77–1.25)	0.91 (0.72–1.16)	**0.64 (0.43–0.97)**
Cough: yes vs no	1.05 (0.90–1.23)	0.99 (0.80–1.23)	**1.29 (1.02–1.62)**	1.22 (0.98–1.52)	0.87 (0.62–1.22)
Other asthma-related comorbidity*: yes vs no	1.11 (0.91–1.36)	0.94 (0.74–1.21)	1.21 (0.92–1.60)	0.93 (0.70–1.24)	**1.63 (1.12–2.39)**
No. of chronic conditions					
5+ vs 0	0.80 (0.60–1.07)	1.41 (0.84–2.35)	0.71 (0.42–1.19)	0.88 (0.46–1.68)	1.04 (0.12–8.68)
3–4 vs 0	**0.76 (0.60–0.97)**	1.17 (0.72–1.90)	0.73 (0.46–1.17)	0.84 (0.45–1.57)	1.50 (0.18–12.35)
1–2 vs 0	0.87 (0.71–1.06)	1.46 (0.93–2.29)	0.81 (0.53–1.24)	0.92 (0.51–1.65)	1.35 (0.17–10.90)

Bold type indicates statistically significant result.

**Tonsillitis, conjunctivitis, or nasal polyposis.*

CI = confidence interval; OCS = oral corticosteroid; URI = upper respiratory infection.

Our goal was to describe the current level of compliance to determine changes needed to improve asthma care. We conclude that current asthma care will have to change significantly to be brought in line with the 2007 NHLBI Asthma Guidelines. Aligning patients' asthma therapy with guidelines, including more ICS and less OCS use, would improve the health of asthma patients. With concerted effort, increased guideline adherence is achievable. The National Committee for Quality Assurance reports a >40% increase in adherence to the asthma measure over 6 years.[9] We reviewed care that occurred before EPR3 was released, so clinicians could not have been trying to comply with the guidelines and should not be faulted for these findings. Our claims-based algorithm for step assignment may make ongoing studies of the quality of asthma care easier to conduct.

APPENDIX

Definition of Therapy Steps

Therapy Step	Definition
1	Short-acting β agonist (SABA) only
2	No long-acting β agonist (LABA) Any of the following: low-dose ICS, cromolyn sodium, LTRA, nedocromil, and/or theophylline
3	Low-dose ICS and LABA Medium-dose ICS, but no LABA Low-dose ICS and either LTRA, theophylline, or zileuton
4	Medium-dose ICS and LABA Medium-dose ICS and either LTRA, theophylline, or zileuton
5	High-dose ICS and LABA (and omalizumab if evidence of allergy)
6	High-dose ICS, LABA, and long-term use of OCSs (and omalizumab if evidence of allergy)
No asthma treatment	No use of any asthma medication
Undefined	Asthma treatment not fitting any aforementioned step 1–6

ICS = inhaled corticosteroid; LTRA = leukotriene receptor antagonist; OCS = oral corticosteroid.

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